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SUPPLEMENT 205

FUNGICIDAL AND PHYTOTOXIC PROPERTIES OF 412 SYNTHETIC ORGANIC COMPOUNDS

Supplement 205 July 15, 1951

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PLANT DISEASE REPORTER SUPPLEMENT

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station
Beltsville, Maryland

FUNGICIDAL AND PHYTOTOXIC PROPERTIES OF 412 SYNTHETIC ORGANIC COMPOUNDS[1]

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A previous publication[2] discussed the fungicidal and phytotoxic properties of 506 synthetic organic chemicals. This paper gives the results of similar tests with 412 additional synthetic organic compounds.

The methods used and the objectives sought in this second study do not differ essentially from those described in the first paper. They consisted, in general, of preparing suspensions of the chemicals in water from which residues were produced on cover slips and on peach foliage. The residues dried on the cover slips were subjected to test as fungicides by seeding them with suspensions of the conidia of *Monilinia fructicola* (Wint.) Honey (peach brown rot pathogen) and *Glomerella cingulata* (Ston.) Spauld. & Schrenk (apple bitter rot pathogen) and determining the germination of the spores. In these tests as before, the cover slips bearing the residues were made in sufficient number so that some could be tested immediately in the laboratory and others could be tested after periods of exposure in an apple orchard environment. This exposure, accomplished by suspending in apple trees the cover slips clamped in special holders, permitted periodical determinations of the effect of weathering on the fungicidal property of each chemical. All the chemicals were subjected to at least one weathering test. If any were found to possess fungicidal properties, they were subjected to more than one weathering test.

Phytotoxic tests were conducted along with the fungicidal tests. After the residues had been prepared on the cover slips, the remaining suspension was sprayed on the leaves of peach trees. The sprayed foliage was examined during a period of several weeks to determine the accumulative effect of the orchard environment on phytotoxicity.

In the initial tests all the compounds were ground up in an equal quantity, by weight, of pyrophyllite to insure a more favorable particle size for suspension. When a compound proved to be promising, i.e., possessed fungicidal properties, it was formulated also with DDT, benzene hexachloride, or parathion to study its fungicidal and phytotoxic properties in combination with these commonly used organic insecticides.

The procedures described in the previous paper were modified slightly. Plastic cover slips were substituted for fragile glass cover slips. This change eliminated loss of test materials through wind breakage. A 50-50 mixture of Czapek's solution and beef bouillon was substituted for the dilute Czapek's solution used in the earlier work to promote spore germination.

Results

Screening tests showed that 388 (listed in Table 1) of the 412 compounds tested did not possess fungicidal properties.

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[1] The Plant Disease Survey recognizes that the material presented in this Supplement differs from the usual content of the *Plant Disease Reporter*, and may not be of direct interest to many of its readers. It is issued as a special contribution because of its fundamental importance. The Survey does not assume responsibility for the subject matter. The expense of publication is borne by the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering. P.R.M.

[2] Goldsworthy, M. C., and S. I. Gertler. Fungicidal and phytotoxic properties of 506 synthetic organic compounds. Plant Dis. Reptr. Suppl. 182: [89]-109. 1949.

The 24 chemicals found to possess fungicidal properties are listed in Table 2. Of these 24, nine were found to be too phytotoxic to warrant further consideration. Two of the remaining 15 (N-ethyl anisamide and 2, 3, 5-trichloro-6-phenyl-p-quinone) caused mild injury to peach foliage, but one of these (2, 3, 5-trichloro-6-phenyl-p-quinone) was sufficiently promising as a fungicide to warrant further tests. None of the remaining 13 compounds were phytotoxic but only four of these [N-ethyl-p-nitrobenzamide; carbonic acid, bis (p-nitrophenyl) ester; 2, 3, 6, 7-tetrachloro-5, 6, 7, 8-tetrahydronaphthoquinone; and 2, 2'-thiobis (4-chlorophenol)] appeared to be promising enough to be studied more intensively.

Table 3 shows the fungicidal and phytotoxic properties of 11 of the chemicals when formulated with pyrophyllite, DDT, benzene hexachloride, or parathion. In some cases duration of fungicidal effectiveness was less when a chemical was formulated with one of the insecticides than when it was formulated with pyrophyllite.

Of the 412 compounds tested, only the previously listed appeared to be of promise as fungicides. [These 5 are N-ethyl-p-nitrobenzamide; bis (p-nitrophenyl) ester of carbonic acid; 2, 3, 6, 7-tetrachloro-5, 6, 7, 8-tetrahydronaphthoquinone; 2, 2'-thiobis (4-chlorophenol); and 2, 3, 5-trichloro-6-phenyl-p-quinone.] Two of these, the bis (p-nitrophenyl) ester of carbonic acid and 2, 2'-thiobis(4-chlorophenol), have reached the orchard stage in their development. Both have been used on apple and peach varieties experimentally to control the diseases of these fruits. The phenol compound has been found to control apple scab, Brooks' spot, bitter rot, and sooty blotch, but it causes russeting of the fruit of the Golden Delicious, Stayman, York, Grimes Golden, and Delicious varieties of apples. On peaches it proved to be particularly promising in preliminary tests, since it appeared effective in controlling peach scab, brown rot, and, to some degree, bacterial spot without causing any injury to foliage or fruit. The carbonic acid derivative did not cause any leaf or fruit injury to apple or peach and appeared to be fungicidal under orchard conditions. So far we have not been able to procure sufficient quantities of the remaining three promising materials for orchard tests.

Table 1. Organic compounds having no fungicidal activity when applied as sprays formulated with an equal weight of pyrophyllite at the rate of one pound per 100 gallons.[a]

Chemical	Injury to peach leaves[b]
Acetaldehyde, 2-chloroethyl 2, 4, 5-trichlorophenyl acetal	0
Acetamide, alpha, alpha, alpha-trichloro-N-2-thiazolyl-	Very severe
Acetanilide, 3-chloro-alpha-(pentachlorophenoxy)-	0
Acetanilide, alpha, alpha, alpha, 4-tetrachloro-	0
Acetanilide, alpha, alpha, 4-trichloro-	0
Acetanilide, alpha, alpha, alpha-trichloro-*p*-sulfamyl-	0
Acetic acid, 2-(2, 4-dinitrophenyl) hydrazide	0
Acetic acid, (4, 6-dinitro-*o*-toloxy)-	0
Acetic acid, phenyl-, *m*-tolyl ester	0
Acetic acid, phenyl-, *p*-tolyl ester	0
Acetic acid, *o*-toloxy-	0
Acetic acid, alpha-(trichloromethyl)benzyl ester	0
Acetic acid, 1-trichloromethyl-2, 2'-methylenebis (4, 6-dichlorophenyl) ester	0
Acetic acid, 2, 4, 5-trichlorophenyl ester	0
Acetoacetic acid, alpha, alpha-bis(2-cyanoethyl)-, ethyl ester	0
Acetoacetic acid, alpha, alpha-bis(2-cyanoethyl)-, methyl ester	Slight
Acetone, 2, 4-dinitrophenylhydrazone	0
Acetophenone, 2, 4-dinitrophenylhydrazone	0
m-Acetotoluidide, alpha, alpha, alpha-trichloro-alpha^3, alpha^3, alpha^3-trifluoro-	Severe
Aniline, N-allyl-2, 4-dinitro-	0
Aniline, N-sec-butyl-2, 4-dinitro-	0
Aniline, 2, 5-diethoxy-	0
Aniline, 2, 5-dimethoxy-	0
Anisamide, N-allyl-	Slight
Anisamide, N-benzyl-	0
Anisamide, N-cyclohexyl-	0
Anisamide, N-isobutyl-	0
Anisamide, N-isopropyl-	0
Anisanilide	0
Anisanilide, 4'-bromo-	0
Anisanilide, 2'-chloro-	Slight

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[a] The compounds in all tables are named in the inverted form as used in Chemical Abstracts index in order to group together chemically related compounds as far as possible.

[b] Slight = trace of intercostal or marginal necrotic areas.
Medium = few intercostal or marginal necrotic areas.
Moderate = appreciable spotting of leaves with necrotic areas.
Severe = heavy intercostal and marginal necrosis but no effect on leaf abscission.
Very severe = heavy intercostal and marginal necrosis with leaf abscission.

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Anisanilide, 3'-chloro-	0
Anisanilide, 4'-chloro-	0
Anisanilide, 2', 5'-dichloro-	0
Anisanilide, 2'-nitro-	Slight
Anisanilide, 4'-nitro-	0
o-Anisanisidide	0
p-Anisanisidide	0
Anisic acid, o-bromophenyl ester	0
Anisic acid, p-bromophenyl ester	0
Anisic acid, p-tert-butylphenyl ester	0
Anisic acid, o-chlorophenyl ester	0
Anisic acid, 2, 4-dichlorophenyl ester	0
Anisic acid, p-ethylphenyl ester	0
Anisic acid, o-nitrophenyl ester	0
Anisic acid, p-nitrophenyl ester	0
Anisic acid, pentachlorophenyl ester	0
Anisic acid, phenyl ester	Medium
Anisic acid, phenylhydrazide	Slight
Anisic acid, m-tolyl ester	0
Anisic acid, o-tolyl ester	0
Anisic acid, 2, 4, 6-tribromophenyl ester	0
Anisic acid, 2, 4, 6-trichlorophenyl ester	0
Anisole, 5-allyl-2-(2, 4-dinitrophenoxy)-	0
m-Anisotoluidide	0
o-Anisotoluidide	0
p-Anisotoluidide	0
Anthranilic acid, N-(p-chlorobenzoyl)-	0
Anthranilic acid, N-(2, 4-dichlorobenzoyl)-	0
Benzaldehyde, 4-(2, 4-dinitrophenoxy)-3-methoxy-	0
Benzaldehyde, 2, 4-dinitrophenylhydrazone	0
Benzamide, N-amyl-o-chloro-	0
Benzamide, N-sec-amyl-o-chloro-	0
Benzamide, N-amyl-p-chloro-	0
Benzamide, N-sec-amyl-p-chloro-	0
Benzamide, N-amyl-2, 4-dichloro-	Medium
Benzamide, N-sec-amyl-2, 4-dichloro-	Slight
Benzamide, N-amyl-3, 4-dichloro-	0
Benzamide, N-sec-amyl-3, 4-dichloro-	Moderate
Benzamide, N-benzoxy-	0
Benzamide, N-benzyl-o-chloro-	0
Benzamide, N-benzyl-p-chloro-	0
Benzamide, N-benzyl-2, 4-dichloro-	0
Benzamide, N-benzyl-3, 4-dichloro-	0
Benzamide, N-benzyl-m-nitro-	0
Benzamide, N-benzyl-p-nitro-	0
Benzamide, N-2-bicyclohexyl-p-chloro-	0
Benzamide, N-2-bicyclohexyl-2, 4-dichloro-	0
Benzamide, N-butyl-o-chloro-	0
Benzamide, N-sec-butyl-o-chloro-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Benzamide, N-butyl-*p*-chloro-	0
Benzamide, N-sec-butyl-*p*-chloro-	0
Benzamide, N-butyl-2, 4, dichloro-	0
Benzamide, N-sec-butyl-2, 4, dichloro-	Slight
Benzamide, N-butyl-3, 4-dichloro-	0
Benzamide, N-sec-butyl-3, 4-dichloro-	0
Benzamide, *o*-chloro-	0
Benzamide, *p*-chloro-	0
Benzamide, *o*-chloro-N-cyclohexyl-	0
Benzamide, *p*-chloro-N-cyclohexyl-	0
Benzamide, *p*-chloro-N, N-diisobutyl-	0
Benzamide, *p*-chloro-N, N-diisopropyl-	0
Benzamide, *o*-chloro-N-ethyl-	0
Benzamide, *p*-chloro-N-ethyl-	0
Benzamide, *p*-chloro-N-heptyl-	0
Benzamide, *p*-chloro-N-sec-hexyl-	0
Benzamide, *o*-chloro-N-isobutyl-	0
Benzamide, *p*-chloro-N-isobutyl-	0
Benzamide, *o*-chloro-N-isopropyl-	0
Benzamide, *p*-chloro-N-isopropyl-	0
Benzamide, *p*-chloro-N-methyl-	0
Benzamide, *o*-chloro-N-propyl-	0
Benzamide, *p*-chloro-N-propyl-	0
Benzamide, N-cyclohexyl-*p*-nitro-	0
Benzamide, N, N-dibenzyl-*o*-chloro-	0
Benzamide, N, N-dibenzyl-*p*-chloro-	0
Benzamide, N, N-dibenzyl-3, 4-dichloro-	0
Benzamide, N, N-dibenzyl-*m*-nitro-	0
Benzamide, N, N-dibenzyl-*p*-nitro-	0
Benzamide, 2, 4-dichloro-	0
Benzamide, 3, 4-dichloro-	0
Benzamide, 2, 4-dichloro-N-cyclohexyl-	0
Benzamide, 3, 4-dichloro-N-cyclohexyl-	0
Benzamide, 3, 4-dichloro-N, N-diisobutyl-	0
Benzamide, 2, 4-dichloro-N, N-diisopropyl-	0
Benzamide, 3, 4-dichloro-N, N-diisopropyl-	0
Benzamide, 2, 4-dichloro-N, N-dimethyl-	0
Benzamide, 3, 4-dichloro-N, N-dimethyl-	0
Benzamide, 2, 4-dichloro-N-ethyl-	Medium
Benzamide, 3, 4-dichloro-N-ethyl-	0
Benzamide, 2, 4-dichloro-N-isobutyl-	0
Benzamide, 3, 4-dichloro-N-isobutyl-	0
Benzamide, 2, 4-dichloro-N-isopropyl-	0
Benzamide, 3, 4-dichloro-N-isopropyl-	0
Benzamide, 2, 4-dichloro-N-methyl-	0
Benzamide, 3, 4-dichloro-N-methyl-	0
Benzamide, 2, 4-dichloro-N-propyl-	0
Benzamide, 3, 4-dichloro-N-propyl-	0
Benzamide, N, N^1-ethylenebis/ 2, 4-dichloro-	0
Benzamide, N-(2-hydroxyethyl)-*p*-nitro-	Slight
Benzanilide, 4'-benzoyl-4-chloro-	0
Benzanilide, 4'-bromo-2-chloro-	0
Benzanilide, 4'-bromo-4-chloro-	0
Benzanilide, 2'-bromo-2, 4-dichloro-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Benzanilide, 2'-bromo-3, 4-dichloro-	0
Benzanilide, 4'-bromo-2, 4-dichloro-	0
Benzanilide, 4'-bromo-3, 4-dichloro-	0
Benzanilide, 2-chloro-	0
Benzanilide, 4-chloro-	0
Benzanilide, 2-chloro-2'-nitro-	0
Benzanilide, 2-chloro-3'-nitro-	0
Benzanilide, 2-chloro-4-nitro-	0
Benzanilide, 2-chloro-4'-nitro-	0
Benzanilide, 3'-chloro-4-nitro-	0
Benzanilide, 4-chloro-2'-nitro-	0
Benzanilide, 4-chloro-3'-nitro-	0
Benzanilide, 4-chloro-4'-nitro-	0
Benzanilide, 4'-chloro-4-nitro-	0
Benzanilide, 4-chloro-4'-phenylazo-	0
Benzanilide, 2, 2'-dichloro-	0
Benzanilide, 2, 3'-dichloro-	0
Benzanilide, 2, 4-dichloro-	0
Benzanilide, 2', 4-dichloro-	0
Benzanilide, 2, 4'-dichloro-	0
Benzanilide, 3', 4-dichloro-	0
Benzanilide, 4, 4'-dichloro-	0
Benzanilide, 2, 4-dichloro-2'-nitro-	0
Benzanilide, 2, 4-dichloro-3'-nitro-	0
Benzanilide, 2, 4-dichloro-4'-nitro-	0
Benzanilide, 2', -5'-dichloro-4-nitro-	0
Benzanilide, 3, 4-dichloro-2'-nitro-	0
Benzanilide, 3, 4-dichloro-3'-nitro-	0
Benzanilide, 3, 4-dichloro-4'-nitro-	0
Benzanilide, 2, 4-dichloro-2'-phenyl-	0
Benzanilide, 2, 4-dichloro-4'-phenylazo-	0
Benzanilide, *o*'-hydroxy-	0
Benzanilide, 4-nitro-	0
Benzanilide, 2, 2', 4, 5'-tetrachloro-	0
Benzanilide, 2', 3, 4, 5-tetrachloro-	0
Benzanilide, 2, 2', 4-trichloro-	0
Benzanilide, 2, 2', 5'-trichloro-	0
Benzanilide, 2, 3, 4-trichloro-	0
Benzanilide, 2, 3', 4-trichloro-	0
Benzanilide, 2, 4, 4'-trichloro-	0
Benzanilide, 2', 4, 5'-trichloro-	0
Benzanilide, 3, 3', 4-trichloro-	0
Benzanilide, 3, 4, 4'-trichloro-	0
o-Benzanisidide, 2-chloro-	0
o-Benzanisidide, 4-chloro-	0
p-Benzanisidide, 2-chloro-	0
p-Benzanisidide, 4-chloro-	0
o-Benzanisidide, 2, 4-dichloro-	0
p-Benzanisidide, 2, 4-dichloro-	0
p-Benzanisidide, 3, 4-dichloro-	0
Benzene, 1, 3-bis(2, 4-dinitrophenoxy)-	0
Benzene, 1, 4-bis(2, 4-dinitrophenoxy)-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Benzenesulfonamide, 3, 4-dichloro-N-methyl-	0
Benzoic acid, *o*-benzamidophenyl ester	0
Benzoic acid, benzylidenehydrazide	0
Benzoic acid, *p*-chloro-, pentachlorophenyl ester	0
Benzoic acid, *o*-chloro-, phenylhydrazide	0
Benzoic acid, cinnamylidenehydrazide	0
Benzoic acid, 2, 4-dichloro-, *p*-bromophenyl ester	0
Benzoic acid, 2, 4-dichloro-, *o*-chlorophenyl ester	0
Benzoic acid, 3, 4-dichloro-, *o*-chlorophenyl ester	0
Benzoic acid, 2, 4-dichloro-, *o*-nitrophenyl ester	0
Benzoic acid, 3, 4-dichloro-, *o*-nitrophenyl ester	0
Benzoic acid, 2, 4-dichloro-, pentachlorophenyl ester	0
Benzoic acid, 3, 4-dichloro-, pentachlorophenyl ester	0
Benzoic acid, 2, 4-dichloro-, phenylhydrazide	0
Benzoic acid, 3, 4-dichloro-, phenylhydrazide	0
Benzoic acid, *o*-(2, 4-dinitrophenoxy)-	0
Benzoic acid, alpha-methylbenzylidenehydrazide	0
Benzoic acid, *p*-nitro-, benzylidenehydrazide	0
Benzoic acid, *p*-nitro-, butylidenehydrazide	0
Benzoic acid, *p*-nitro-, *p*-tert-butyliphenyl ester	0
Benzoic acid, *p*-nitro-, *o*-chlorobenzylidenehydrazide	0
Benzoic acid, *p*-nitro-, cinnamylidenehydrazide	0
Benzoic acid, *p*-nitro-, cyclohexylidenehydrazide	0
Benzoic acid, *p*-nitro-, cyclopentylidenehydrazide	0
Benzoic acid, *p*-nitro-, 2, 4-dichlorophenyl ester	0
Benzoic acid, *p*-nitro-, 2-ethylbutylidenehydrazide	0
Benzoic acid, *p*-nitro-, hydrazide	0
Benzoic acid, *p*-nitro-, isopropylidenehydrazide	0
Benzoic acid, *p*-nitro-, gamma-keto-alpha-methylbutylidenehydrazide	0
Benzoic acid, *p*-nitro-, alpha-methybenzylidenehydrazide	0
Benzoic acid, *p*-nitro-, methylenehydrazide	0
Benzoic acid, *p*-nitro-, alpha-methylpropylidenehydrazide	0
Benzoic acid, *p*-nitro-, *p*-nitrophenyl ester	0
Benzoic acid, *p*-nitro-, pentachlorophenyl ester	0
Benzoic acid, *p*-nitro-, piperonylidenehydrazide	0
Benzoic acid, *p*-nitro-, propylidenehydrazide	0
Benzoic acid, *m*-nitro-2-(2-pyridyl) ethyl ester	0
Benzoic acid, *p*-nitro-, 2-(2-pyridyl) ethyl ester	0
Benzoic acid, *p*-nitro-, tetrahydrofurfuryl ester	0
Benzoic acid, *p*-nitro-, *m*-tolyl ester	0
Benzoic acid, *p*-nitro-, *o*-tolyl ester	0
Benzoic acid, *p*-nitro-, *p*-tolyl ester	0
Benzoic acid, *p*-nitro-, 2, 2, 2-trichloroethylidenehydrazide	0
Benzoic acid, *p*-nitro-, 2, 4, 6-trichlorophenyl ester	0
Benzoic acid, piperonylidenehydrazide	0
Benzoic anhydride, *p*-chloro-	0
m-Benzotoluidide, 2-chloro-	0
m-Benzotoluidide, 4-chloro-	0
o-Benzotoluidide, 2-chloro-	0
o-Benzotoluidide, 4-chloro-	0
p-Benzotoluidide, 2-chloro-	0
p-Benzotoluidide, 4-chloro-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
m-Benzotoluidide, 2, 4-dichloro-	0
m-Benzotoluidide, 3, 4-dichloro-	0
p-Benzotoluidide, 2, 4-dichloro-	0
Benzoxazole, 2-phenoxymethyl-	0
Benzoxazole, 2-phenyl-	0
Benzylamine, N-(2, 4-dinitrophenyl)-	0
2-Butanone, 2, 4-dinitrophenylhydrazone	0
Butyraldehyde, 2, 4-dinitrophenylhydrazone	0
Butyric acid, 2-(2, 4-dinitrophenyl)hydrazide	0
Caproic acid, 2, 3, 4, 5-tetrabromo-	0
Carbonic acid, bis(p-chlorophenyl) ester	0
Carbonic acid, bis(2, 4-dichlorophenyl) ester	0
Carbonic acid, bis(2, 4-dinitrophenyl) ester	0
Carbonic acid, bis(pentachlorophenyl) ester	0
Carbonic acid, bis(2, 3, 4, 6-tetrachlorophenyl) ester	0
Carbonic acid, bis(2, 4, 6-trichlorophenyl) ester	0
Carbonic acid, di-m-tolyl ester	0
Carbonic acid, di-o-tolyl ester	0
Carbonic acid, di-p-tolyl ester	0
Chloroacetic acid, p-biphenylyl ester	0
Chloroacetic acid, diester with 2, 2'-methylenebis (4-chlorophenol)	0
Chloroacetic acid, p, p'-thiodiphenyl diester	0
o-Cresol, 4, 6-dinitro-, p-toluenesulfonate	0
o-Cresol, alpha-(hydroxyphenylimino)-	0
1, 1, 3, 3-Cyclohexanetetrapropionitrile, 2-oxo-	0
Cyclohexanone, 2, 4-dinitrophenylhydrazone	0
2-Cyclohexene-1-one, 2, 3, 4, 4, 5, 6, 6-heptachloro-	0
Cyclohexylamine, N-(2, 4-dinitrophenyl)-	0
1, 1, 3, 3-Cyclopentanetetrapropionitrile, 2-oxo-	Medium
Cyclopentanone, 2, 4-dinitrophenylhydrazone	0
Dibenzylamine, N-(2, 4-dinitrophenyl)-	Slight
Diphenylamine, 4-chloro-2-nitro-	0
Ethane, 1-(p-tert-butylphenoxy)-2-(2, 4-dinitrophenoxy)-	0
Ethane, 1, 1-dichloro-2, 2-bis(4-hydroxy-3, 5-dinitrophenyl)-	0
Ethane, 1, 1, 1-trichloro-2, 2-bis(4-chloro-3, 5-dinitrophenyl)-	0
Ethane, 1, 1, 1-trichloro-2, 2-bis(2, 5-dimethoxyphenyl)-	0
Ethane, 1, 1, 1-trichloro-2, 2-bis(p-fluorophenyl)-	0
Ethane, 1, 1, 1-trichloro-2, 2-bis(p-fluorophenyl)-(technical)	0
Ethanol, 2-(2, 4-dinitroanilino)-	0
Ethanol, 2-(2, 4-dinitrophenoxy)-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Ethanol, 2, 2'-(phenylimino)di-	0
Ethanol, 2, 2'-(m-tolylimino)di-	0
Ethanol, 2-(alpha^{3}, alpha^{3}, alpha^{3}-trifluoro-m-toloxy)-	0
Ether, benzyl 2, 4-dinitrophenyl	0
Ether, 2-bromo-4-tert-butylphenyl 2, 4-dinitrophenyl	0
Ether, p-bromophenyl 2, 4-dinitrophenyl	0
Ether, 4-tert-butyl-2-chlorophenyl 2, 4-dinitrophenyl	0
Ether, p-tert-butylphenyl 2, 4-dinitrophenyl	0
Ether, o-chlorophenyl 2, 4-dinitrophenyl	0
Ether, p-chlorophenyl 2, 4-dinitrophenyl	0
Ether, 2-biphenylyl 2, 4-dinitrophenyl	0
Ether, 4-biphenylyl 2, 4-dinitrophenyl	0
Ether, cyclohexyl 2, 4-dinitrophenyl	0
Ether, o-cyclohexylphenyl 2, 4-dinitrophenyl	0
Ether, 2, 4-dichlorophenyl 2, 4-dinitrophenyl	0
Ether, p(alpha, alpha-dimethylbenzyl)phenyl 2, 4-dinitrophenyl	0
Ether, 2, 4-dinitrophenyl 4-methylcyclohexyl	0
Ether, 2, 4-dinitrophenyl alpha-naphthyl	0
Ether, 2, 4-dinitrophenyl beta-naphthyl	0
Ether, 2, 4-dinitrophenyl m-nitrophenyl	0
Ether, 2, 4-dinitrophenyl o-nitrophenyl	0
Ether, 2, 4-dinitrophenyl p-nitrophenyl	0
Ether, 2, 4-dinitrophenyl 2-nitro-p-tolyl	0
Ether, 2, 4-dinitrophenyl phenethyl	0
Ether, 2, 4-dinitrophenyl phenyl	0
Ether, 2, 4-dinitrophenyl tetrahydrofurfuryl	0
Ether, 2, 4-dinitrophenyl o-tolyl	0
Ether, 2, 4-dinitrophenyl p-tolyl	0
Ether, 2, 4-dinitrophenyl 2, 4, 6-trichlorophenyl	0
Ethylenediamine, N, N'-bis(disalicylidene)-, copper salt	Severe
Ethylenediamine, N, N'-bis(disalicylidene)-, ferrous salt	0
Ethylenediamine, N, N'-bis(disalicylidene)-, nickel salt	0
Ethylenediamine, N, N'-bis(disalicylidene)-, zinc salt	0
Formaldehyde, 2-4-dinitrophenylhydrazone	0
Glycine, N-(2, 4-dinitrophenyl)-	Slight
2-Heptanone, 2, 4-dinitrophenylhydrazone	0
Hippuric acid, p-chloro-	0
Hydrazine, 1, 2-dibenzoyl-	0
Hydroquinone, diacetate	0
Hydroquinone, 2, 5-di-tert-butyl-	0
2-Imidazolidinethione	Moderate
Isobutyraldehyde, 2, 4-dinitrophenylhydrazone	0
Isobutyric acid, 2-(2, 4-dinitrophenyl) hydrazide	0
5(4)Isoxazolone, 4-cinnamylidene-3-methyl-	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Mesityl oxide, 2, 4-dinitrophenylhydrazone	0
Methanetripropionitrile, *p*-anisoyl-	0
Methanetripropionitrile, benzoyl-	Slight
Methanetripropionitrile, *p*-bromobenzoyl-	0
Methanetripropionitrile, *p*-chlorobenzoyl-	Slight
Methanetripropionitrile, 3, 4-dichlorobenzoyl-	0
Methanetripropionitrile, 2-naphthoyl-	0
Methanetripropionitrile, *p*-toluyl-	0
Morpholine, 4-(*o*-chlorobenzoyl)-	0
Morpholine, 4-(*p*-chlorobenzoyl)-	0
Morpholine, 4-(2, 4-dichlorobenzoyl)-	Moderate
Morpholine, 4-(3, 4-dichlorobenzoyl)-	0
Morpholine, 4-(*p*-nitrobenzoyl)-	0
Naphthalene, 1, 5-bis(2, 4-dinitrophenoxy)-	0
1, 5-Naphthalenediol	0
1-Naphthalenepropionamide, N-cyclohexyl-2-hydroxy-	0
1-Naphthalenepropionitrile, 2-hydroxy-	0
3-Napthoic acid, 1, 1-methylene bis [2-hydroxy-	0
1-Naphthol, acetate	Medium
2-Naphthol, acetate	Medium
5(4H)-Oxazolone, 2-phenyl-4-piperonylidene-	0
Phenetole, 2, 4-dinitro-	0
Phenol, *o*-(anisylideneamino)-	0
Phenol, *o*-(benzylideneamino)-	0
Phenol, *p*-butylamino-	0
Phenol, *o*-(*o*-chlorobenzylideneamino)-	0
Phenol, *o*-(*p*-chlorobenzylideneamino)-	0
Phenol, 4-chloro-2, 6-dinitro-	Very severe
Phenol, *o*-cyclohexyl-4, 6-dinitro-, *p*-toluenesulfonate	0
Phenol, *o*-(2, 4-dinitroanilino)-	0
Phenol, *p*-(2, 4-dinitroanilino)-	Slight
Phenol, 2, 4-dinitro-, *p*-toluenesulfonate	0
Phenol, *p*-methoxy-	0
Phenol, 2, 2'-methylenebis[4-chloro-, diacetate	0
Phenol, *p*-nitro-, acetate	0
Phenol, *m*-nitro-, *p*-toluenesulfonate	0
Phenol, 2, 2'-sulfonylbis[4-chloro-	0
Phenol, 2, 4, 6-tribromo-, acetate	0
Phenol, 1 trichloromethyl-4, 4'-methylenebis[2, 6-dichloro-	0
Pimelonitrile, gamma-benzoyl-gamma-methyl-	0
beta-Pinene, carbon tetrachloride addition product (49% Cl)	0
beta-Pinene, hexachloroethane addition product (59% Cl)	0

Table 1. (Continued)

Chemical	Injury to peach leaves[b]
Piperidine, 1-(o-chlorobenzoyl)-	0
Piperidine, 1-(p-chlorobenzoyl)-	0
Piperidine, 2, 4-dichlorobenzoyl-	0
Piperidine, 1-(p-nitrobenzoyl)-	0
Propane, 1, 3-dichloro-2, 2-bis(chloromethyl)-	0
1, 3-Propanediol, bis(chloromethyl)-	0
1, 3-Propanediol, 2, 2-bis(chloromethyl)-, bis(p-chlorobenzoate)	0
1, 3-Propanediol, 2, 2-bis(chloromethyl)-, bis(2, 4 dichlorobenzoate)	0
1-Propanol, 3-chloro-2, 2-bis(chloromethyl)-	0
1-Propanol, 3-chloro-2, 2-bis(chloromethyl)-, p-chlorobenzoate	0
1-Propanol, 3-chloro-2, 2-bis(chloromethyl)-, 2, 4-dichlorobenzoate	0
Propionic acid, 2-(2, 4-dinitrophenyl)hydrazide	0
Pyrophosphoramide, octomethyl-	0
p-Quinone, 2, 5-di-tert-butyl-	0
Sulfanilanilide, 4'-nitro-	0
Sulfide, bis(2, 4-dinitrophenyl)-	0
Sulfone, benzyl p-chlorophenyl-	0
Sulfone, bis(p-chlorophenyl)	0
Sulfone, p-chlorobenzyl p'-chlorophenyl-	0
Sulfone, p-chlorobenzyl phenyl	0
4-Thiazoline, 4-phenyl-3-o-tolyl-2-(o-tolylimino)-	Slight
Thiophosphate, O-ethyl-O, O-bis(p-nitrophenyl)-	0
Tris(p-nitrophenyl) phosphate	0
s-Trithiane	0

Table 2. Organic chemicals found possessing fungicidal properties when formulated with an equal weight of pyrophyllite.

Compound[a]	Days effective during 14-day test period[b] against conidia of		Injury to peach leaves[c]
	Monilinia fructicola	*Glomerella cingulata*	
Acetic acid, *o*-cyclohexylphenoxy-	7	7	0
Acetic acid, 2, 4-dinitrophenoxy-	2 (2)	2 (2)	Medium
Anisamide, N-ethyl-	2	2	Mild
Anisamide, N-methyl-	2	2	Medium
Anisamide, N-propyl-	7	7	Moderate
Benzamide, N-ethyl-*p*-nitro-	14	14	0
Benzamide, N-hydroxy-	2 (2)	2 (2)	Medium
Benzoic acid, *p*-chloro-, phenylhydrazide	6	6	0
Benzoic acid, 2, 4-dichloro-, 2-methyl-2-nitrophenyl ester	2 (2)	2 (2)	Medium
Benzoic acid, isopropylidenehydrazide	2 (10)	2 (10)	0
Biuret, 2, 4-dithio	2 (2)	2 (2)	Moderate
Carbonic acid, bis(*p*-nitrophenyl) ester	14	14	0
Ether, 2-cyclohexyl-4, 6-dinitrophenyl-2, 4 dinitrophenyl	14	14	Moderate
Ethylenediamine, N, N'-bis(disalicylidene), cobalt salt	1 (1)	1 (1)	Severe
5(4)-Isoxazolone, 4-benzylidene-3-methyl-	7	7	0
Naphthoquinone, 2, 3, 6, 7-tetrachloro-5, 6, 7, 8-tetrahydro-	14	14	0
Oxindole, 3-hydroxy-3-nitrophenyl-	2	2	0
Phenol, 2-chloro-4, 6-dinitro-	2 (2)	2 (2)	Very severe
Phenol, 2, 2'-thiobis/4-chloro-	14	14	0
p-Quinone, 2, 3, 5-trichloro-6-phenyl-	14	14	Mild
Rhodanine, 5-ethylidene-	7	7	0
Salicylamide, N-propyl-	7	7	0
p-Toluhydroquinone	2	2	0
m-Toluic acid, 2-(2, 4-dinitrophenoxy)-	2	2	0

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[a] See footnote a, Table 1.

[b] Figures in parenthesis show length of test period when less than 14 days.

[c] See footnote b, Table 1.

Table 3. Fungicidal and phytotoxic properties of the most promising organic chemicals when mixed with DDT, benzenehexachloride, parathion, or pyrophyllite.

Compound[a]	Adjuvant[b]	Days effective during test period[c] against conidia of		Injury to peach foliage[d]	Rainfall during test
		Monilinia fructicola	Glomerella cingulata		inches
Acetic acid, *o*-cyclohexylphenoxy-	Pyrophyllite	7 (14)	7 (14)	0	3.16
	Benzenehexachloride	0 (14)	0 (14)	0	3.16
	DDT	3 (14)	3 (14)	0	3.16
Anisamide, N-propyl-	Pyrophyllite	7 (21)	7 (21)	Moderate	4.29
	Benzenehexachloride	7 (21)	7 (21)	Moderate	4.29
	DDT	7 (21)	7 (21)	Moderate	4.29
	Parathion	2 (21)	2 (21)	Severe	4.29
Benzamide, N-ethyl-*p*-nitro-	Pyrophyllite	21 (21)	21 (21)	0	0.98
	Benzenehexachloride	14 (21)	14 (21)	0	5.10
	DDT	14 (21)	14 (21)	0	5.10
	Parathion	21 (21)	21 (21)	0	5.10
Carbonic acid, bis (*p*-nitrophenyl) ester	Pyrophyllite	14 (14)	14 (14)	0	3.42
	Benzenehexachloride	14 (14)	14 (14)	0	3.42
	DDT	14 (14)	14 (14)	0	3.42
	Parathion	14 (14)	14 (14)	0	5.98
Ether, 2-cyclohexyl-4,6-dinitrophenyl-2,4-dinitrophenyl	Pyrophyllite	21 (21)	21 (21)	Moderate	4.29
	Benzenehexachloride	14 (21)	14 (21)	Severe	4.29
	DDT	21 (21)	21 (21)	Moderate	4.29
	Parathion	21 (21)	21 (21)	Severe	4.29
5(4)-Isoxazolone, 4-benzylidene-3-methyl-	Pyrophyllite	7 (14)	7 (14)	0	5.98
	Benzenehexachloride	7 (14)	7 (14)	0	5.98
	DDT	3 (14)	3 (14)	0	5.98
	Parathion	7 (14)	7 (14)	0	5.98
Naphthoquinone, 2,3,6,7-tetrachloro-5,6,7,8-tetrahydro-	Pyrophyllite	21 (21)	21 (21)	0	0.98
	Benzenehexachloride	14 (14)	14 (14)	0	3.42
	DDT	14 (14)	14 (14)	0	5.98
	Parathion	14 (14)	14 (14)	0	5.98
Phenol, 2,2'-thiobis /4-chloro-	None	21 (21)	21 (21)	0	0.98
	Pyrophyllite	21 (21)	21 (21)	Mild	5.19
	DDT	28 (28)	28 (28)	0	1.76

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[a] See footnote [a], Table 1.

[b] Pyrophyllite 1-100; benzenehexachloride 6% gamma 2-100; DDT 50% wettable 2-100; 15% parathion 1-100.

[c] Test period in parenthesis.

[d] See footnote [b], Table 1.

Table 3. (Continued)

Compound[a]	Adjuvant[b]	Days effective during test period[c] against conidia of Monilinia fructicola	Days effective during test period[c] against conidia of Glomerella cingulata	Injury to peach foliage[d]	Rainfall during test
					inches
p-Quinone, 2, 3, 5-trichloro-6-phenyl-	Pyrophyllite	21 (21)	21 (21)	Mild	4.29
	Benzenehexachloride	21 (21)	21 (21)	Medium	4.29
	DDT	21 (21)	21 (21)	Medium	4.29
	Parathion	21 (21)	21 (21)	Medium	4.29
Rhodanine, 5-ethylidene-	Pyrophyllite	7 (14)	7 (14)	0	5.98
	Benzenehexachloride	3 (14)	3 (14)	0	5.98
	DDT	3 (14)	3 (14)	0	5.98
Salicylamide, N-propyl-	Pyrophyllite	7 (14)	7 (14)	0	3.42
	Benzenehexachloride	4 (14)	4 (14)	0	3.42
	DDT	9 (14)	9 (14)	0	3.42
	Parathion	2 (14)	2 (14)	0	3.42

Summary

Data are presented as to the fungicidal and phytotoxic properties of 412 synthetic organic compounds. Of this total 24 compounds were found to possess fungicidal properties, but only 5 appeared promising enough to warrant further orchard tests. These are N-ethyl-p-nitrobenzamide; the bis(p-nitrophenyl) ester of carbonic acid; 2, 3, 6, 7-tetrachloro-5, 6, 7, 8-tetrahydronaphthoquinone; 2, 2'-thiobis(4-chlorophenol); and 2, 3, 5-trichloro-6-phenyl-p-quinone.

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